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(54) **TIRE HAVING GROOVES COMPRISING  
SIPES AND/OR OTHER CROSS-GROOVE  
NEGATIVE GEOMETRY**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Bridgestone Americas Tire  
Operations, LLC**, Nashville, TN (US)

(72) Inventor: **Ruben Lorenzo Madrid**, Copley, OH  
(US)

(73) Assignee: **Bridgestone Americas Tire  
Operations, LLC**, Nashville, TN (US)

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2,268,344 A *	12/1941	Shesterkin .....	B60C 11/0309 152/209.18
3,938,572 A	2/1976	Nishi et al.	
4,334,567 A *	6/1982	Bond .....	B60C 1/0016 152/209.1
6,439,284 B1	8/2002	Fontaine	
7,819,153 B2 *	10/2010	Byrne .....	B60C 11/0302 152/209.16
7,975,738 B2	7/2011	Ohki	
8,132,604 B2	3/2012	Ohara	
8,132,605 B2	3/2012	Nagai	
2003/0047262 A1	3/2003	Kousaie et al.	
2004/0118494 A1	6/2004	Liederer	
2004/0211501 A1	10/2004	Kajita	
2007/0006952 A1	1/2007	Shima et al.	
2010/0132864 A1	6/2010	Colombo et al.	
2011/0061780 A1	3/2011	Mita	
2013/0075001 A1	3/2013	Yasunaga	

(Continued)

FOREIGN PATENT DOCUMENTS

CN	101134426 A	3/2008
JP	S50-098001 A	8/1975

(Continued)

OTHER PUBLICATIONS

Bae, Geun Tae; International Search Report and Written Opinion for  
PCT patent application PCT/US2014/049002; Nov. 4, 2014; pp.  
1-11; Korean Intellectual Property Office; Daejeon Metropolitan  
City, Republic of Korea.

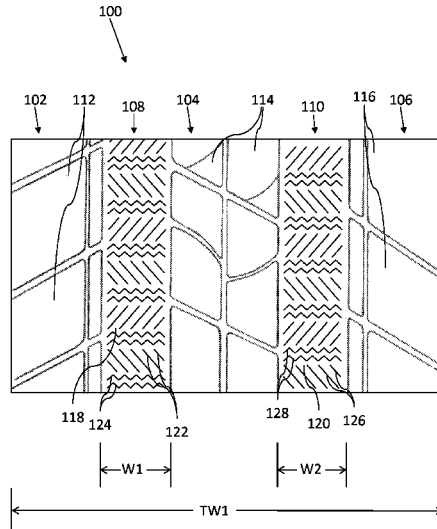
(Continued)

Primary Examiner — Timothy Kennedy  
(74) Attorney, Agent, or Firm — Shaun J. Fox; Thomas Y.  
Kendrick

**ABSTRACT**

(57) Various embodiments of a tire having grooves comprising  
sipes or other cross-groove negative geometry are disclosed.

**8 Claims, 4 Drawing Sheets**



(56)

**References Cited**

U.S. PATENT DOCUMENTS

2013/0092303 A1 4/2013 Kleffmann et al.  
2013/0153100 A1 6/2013 Piffard et al.  
2013/0160909 A1 6/2013 Atake

FOREIGN PATENT DOCUMENTS

JP S63-297108 A 12/1988  
JP S63-314255 12/1988  
JP 2001-287511 A 10/2001  
JP 2003-160696 6/2003  
JP 2009-46052 3/2009  
JP 2009067344 A 4/2009  
JP 2009-166554 7/2009

OTHER PUBLICATIONS

U.S. Department of Homeland Security; What Every Member of the Trade Community Should Know About: Tires; Apr. 2014; pp. 1-28.  
English Abstract for JP2001-287511A, Saguchi Takanari.  
English Abstract for CN101134426A, Masaaki Ohara.  
English Machine translation for JPS50-098001A, Takuji Nishi.  
English Abstract for JPS63-297108A, Inai Sosuke.  
English Abstract for JPS63-314255, Yuto Kazuaki.  
English Abstract for JP2009-166554, Maekita Takashi.  
English Abstract for JP2009-46052, Seta Eisuke.  
English Abstract for JP2003-160696, Sasaka Naohiro.  
Extended European Search Report, dated May 3, 2017, in European Pat. App. No. 14856338.5.  
English machine translation of Abstract for JP2009067344A, Bridgestone Corp.

\* cited by examiner

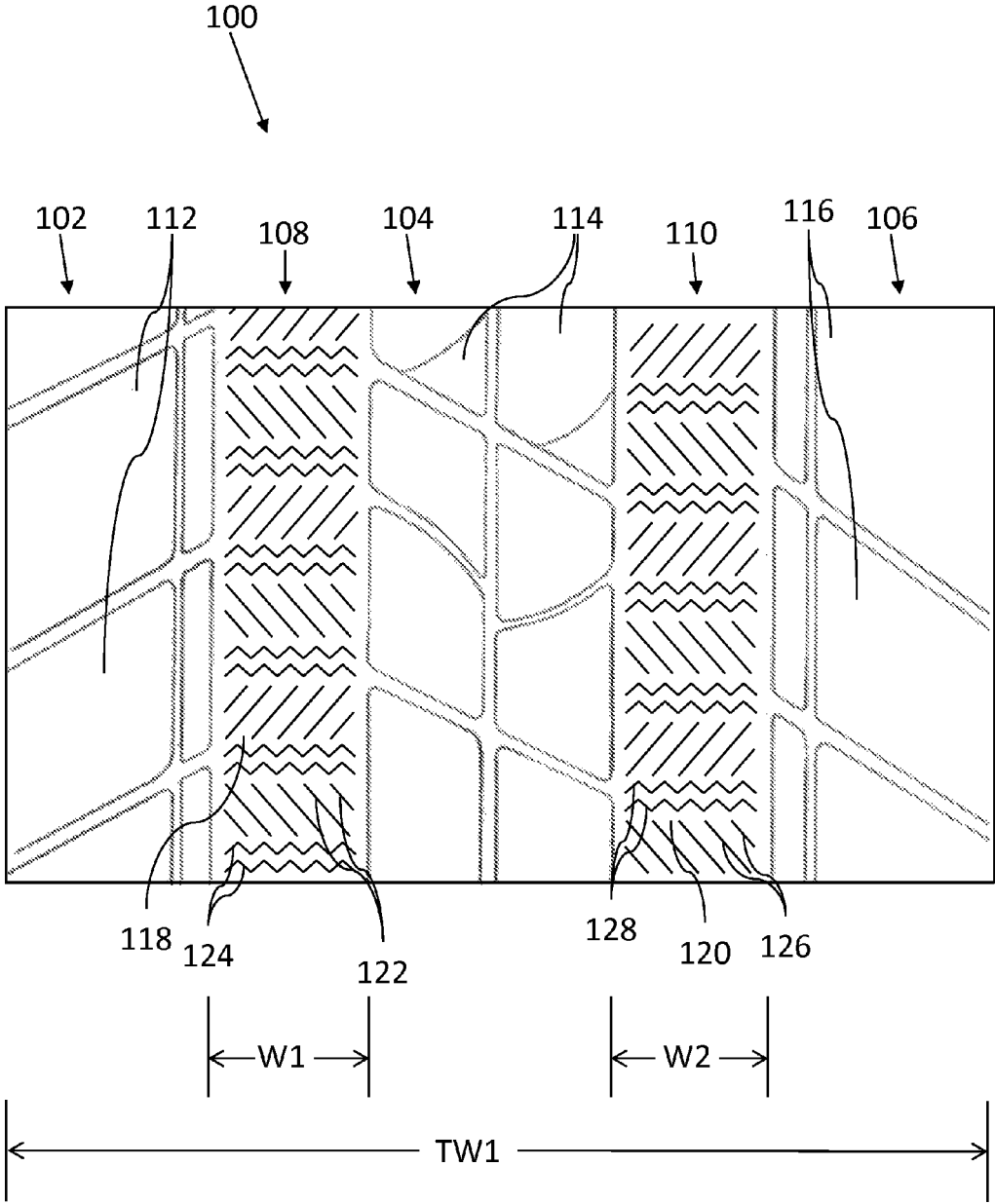


FIG. 1

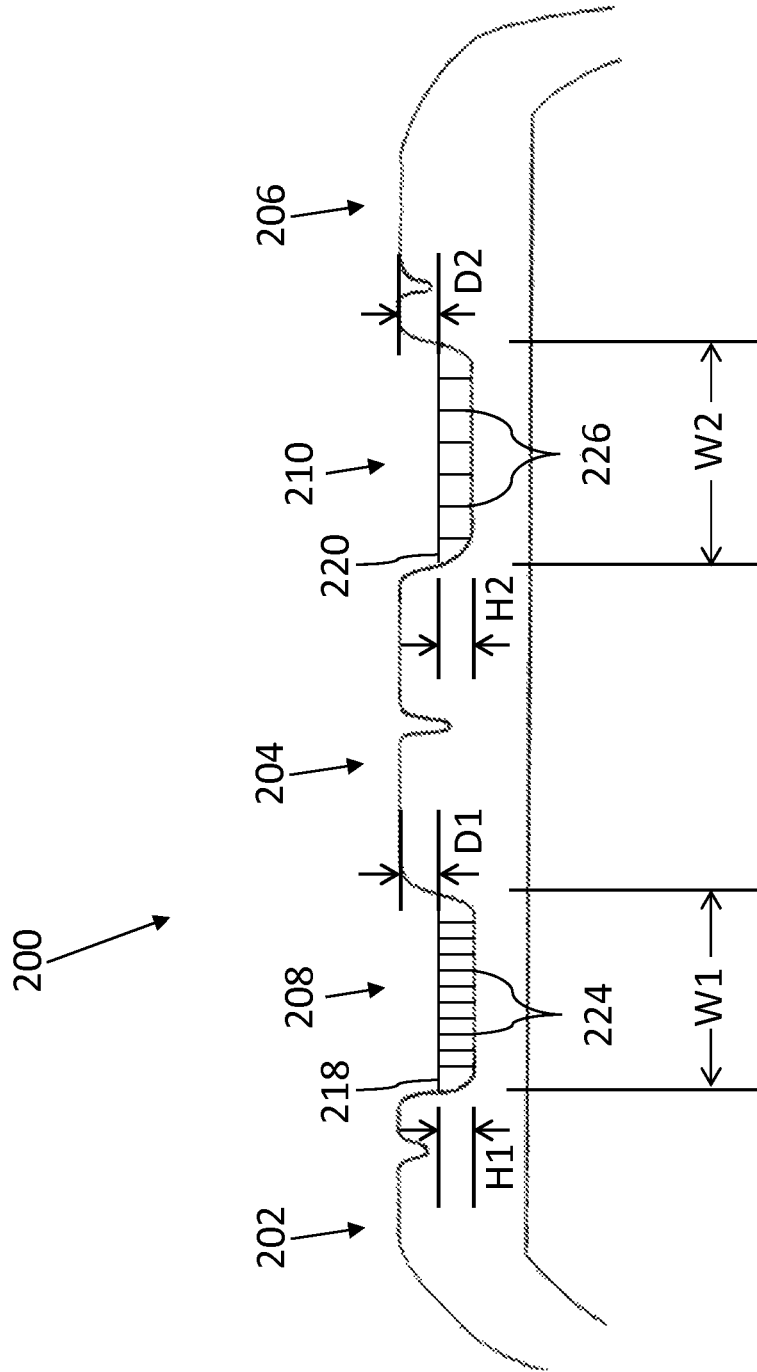
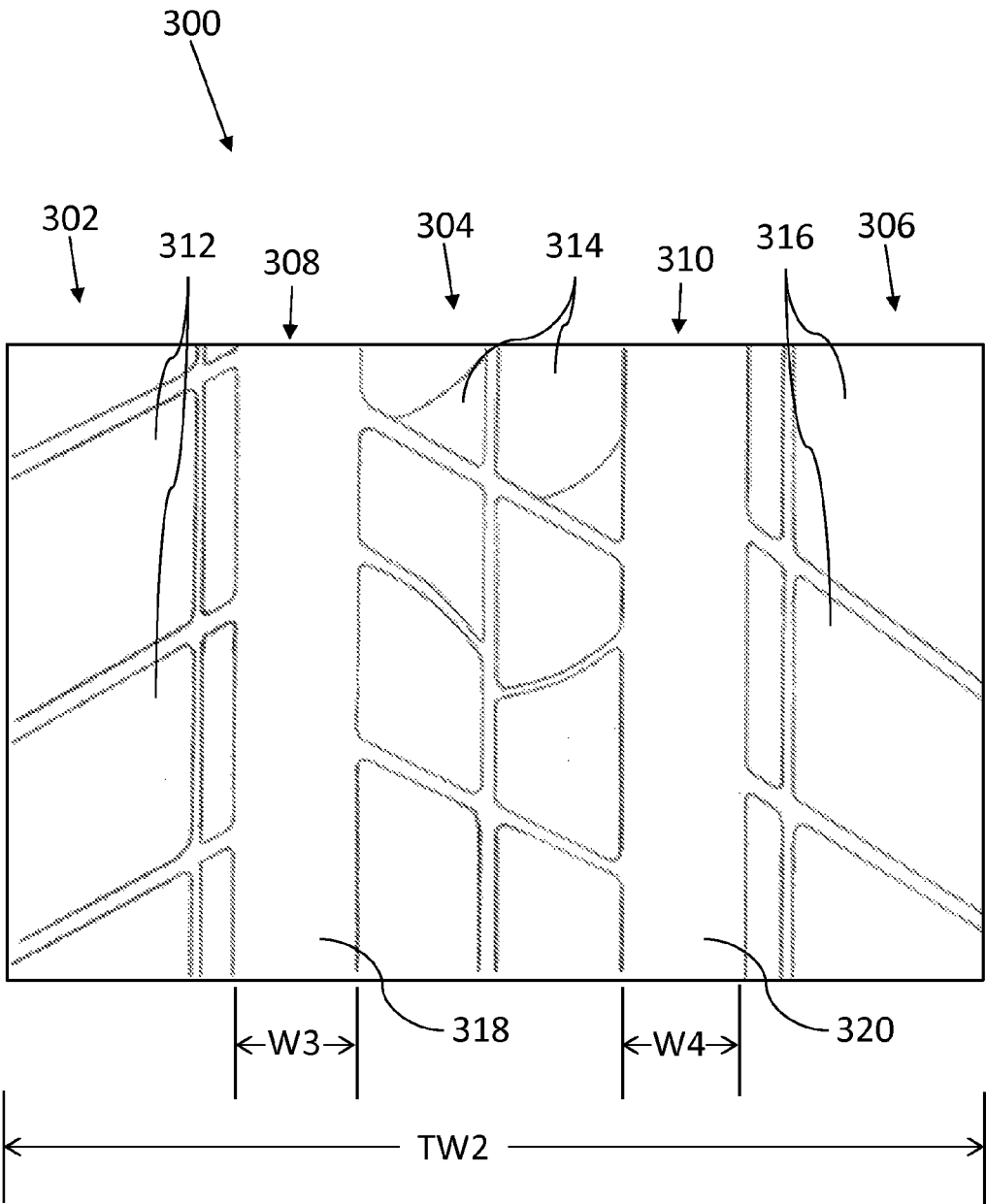
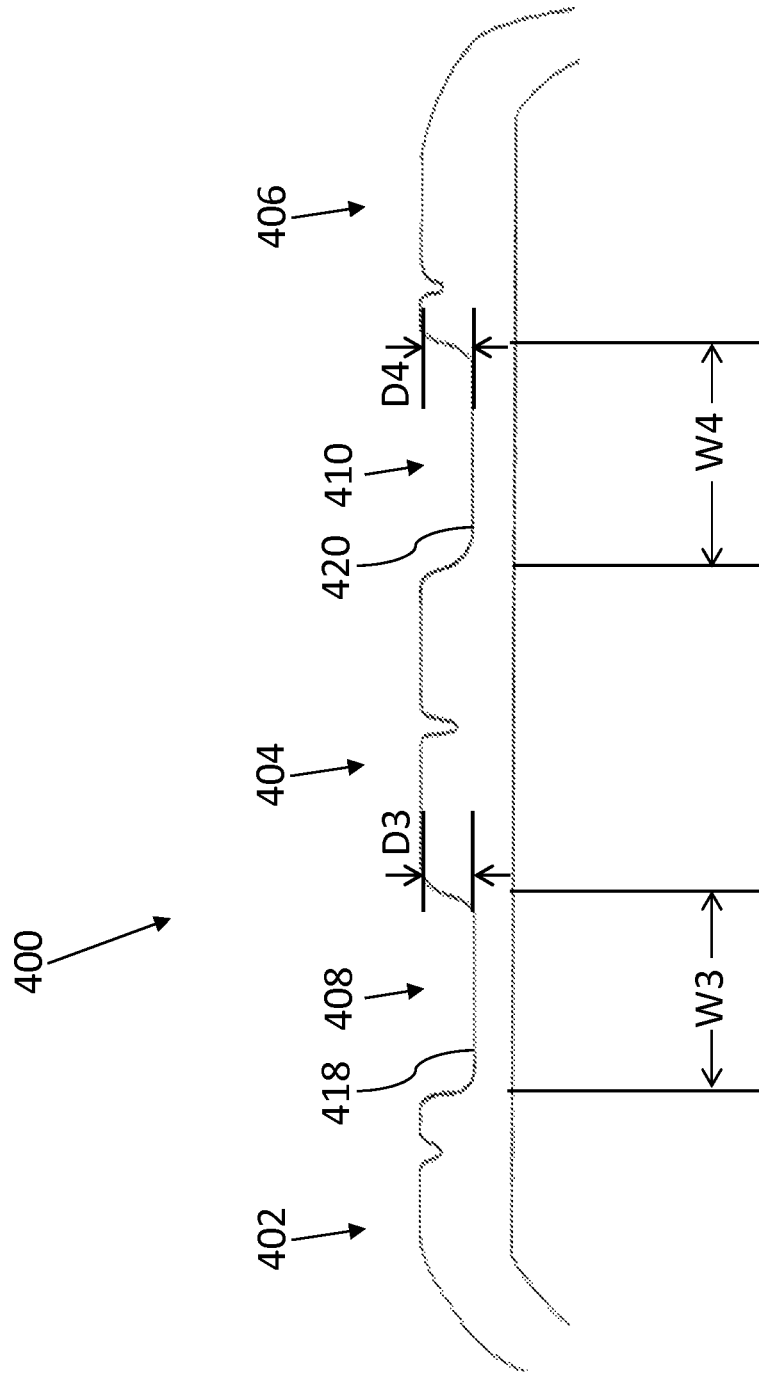


FIG. 2



**FIG. 3**  
PRIOR ART



**FIG. 4**  
PRIOR ART

## TIRE HAVING GROOVES COMPRISING SIPES AND/OR OTHER CROSS-GROOVE NEGATIVE GEOMETRY

### BACKGROUND

Tires, including passenger tires, typically comprise a tread portion including a series of ribs and grooves. The ribs are often oriented to engage a driving surface and provide traction, while the grooves are often oriented to channel and evacuate water that may be present on the driving surface.

Some tires are optimized to provide increased performance in dry/wet conditions, while other tires are optimized to provide increased performance in snow/ice conditions. Additionally, some tires, typically referred to as “all-season” tires, are optimized to provide acceptable performance in both dry/wet conditions, and snow/ice conditions. However, optimization of performance across all seasons is particularly difficult in light of the very distinct mechanisms through which tire performance is increased in these varying conditions.

What is needed is a tire configured to provide increased performance in both dry/wet conditions and snow/ice conditions.

### SUMMARY

In one embodiment, a tire is provided, the tire comprising: a tread portion comprising at least one groove having a groove base, wherein the groove base comprises at least one cross-groove negative geometry.

In another embodiment, a tire is provided, the tire comprising: a tread portion comprising at least one groove, wherein the groove comprises at least one cross-groove negative geometry extending radially inwardly from the groove.

### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying figures, which are incorporated in and constitute a part of the specification, illustrate various example configurations, and are used merely to illustrate various example embodiments. In the figures, like elements bear like reference numerals.

FIG. 1 illustrates a top elevational view of an example embodiment of a tire having grooves comprising a cross-groove negative geometry.

FIG. 2 illustrates a cross-sectional view of an example embodiment of a tire having grooves comprising a cross-groove negative geometry.

FIG. 3 illustrates a top elevational view of an example embodiment of a prior art tire.

FIG. 4 illustrates a cross-sectional view of an example embodiment of a prior art tire.

### DETAILED DESCRIPTION

A tire’s engagement with a road surface is its means for providing traction to the vehicle upon which it is mounted. A tire configured to only operate on relatively smooth, dry surfaces, such as a race track, typically comprises a “slick” or non-patterned design configured to provide maximum engagement between the tire and the driving surface. However, such tires perform poorly when exposed to wet driving surfaces and are prone to hydroplaning. Accordingly, tires are regularly designed to optimize performance across a range of dry and wet operating conditions.

Tires designed to perform best in dry/wet conditions are not necessarily optimized for winter snow/ice conditions. Tires optimized for dry/wet conditions typically include a series of ribs for contacting the driving surface, and a series of grooves for channeling and evacuating water to avoid hydroplaning. Tires optimized for snow/ice conditions typically include tread blocks having an abundance of siping or other cross-groove negative geometry, wherein each sipe creates one or more edge, in addition to the edges of the tread block, configured to provide maximum traction between the tire and the snow or ice.

In addition to the physical features of a tire tread pattern that contribute to optimization of a tire for dry/wet or snow/ice performance, tread compounds can be selected to increase traction in specific operating conditions. For example, a tire may be designed with a high dry grip and high wet grip tread compound in its rib areas, wherein the compound is configured to provide the greatest traction between the tire and the driving surface in dry/wet conditions.

Some tires are configured to provide acceptable performance in dry/wet conditions as well as snow/ice conditions. These tires are typically referred to as “all-season” tires. These all-season tires typically do not perform as well in dry/wet conditions as a tire optimized for dry/wet performance, and do not perform as well in snow/ice conditions as a tire optimized for snow/ice performance. Rather, these tires attempt to provide the best possible performance while recognizing that optimization across a wide range of operating conditions requires a compromise in tire performance.

FIG. 1 illustrates an example embodiment of a tire comprising a tread portion **100**. In one embodiment, the tire is a pneumatic tire. In another embodiment, the tire is a passenger tire. Tread portion **100** may comprise at least one rib, such as ribs **102**, **104**, and **106**. Tread portion **100** may additionally include at least one groove, such as grooves **108** and **110**.

In one embodiment, at least one of ribs **102**, **104**, and **106** comprise a plurality of individual tread blocks, including blocks **112**, **114**, and **116**, respectively. In another embodiment, at least one of ribs **102**, **104**, and **106** comprise continuous ribs extending circumferentially about the tire.

In one embodiment, at least one of ribs **102**, **104**, and **106** comprise at least one of a high dry grip tread compound and a high wet grip tread compound. In another embodiment, at least one of ribs **102**, **104**, and **106** comprise any of a variety of tread compounds, including for example compounds configured for grip, compounds configured for wear, and the like.

In one embodiment, tread portion **100** may comprise any of a variety of tread compounds, including for example compounds configured for grip, compounds configured for wear, and the like. In another embodiment, tread portion **100** may comprise any compound to which it is desirable to add increased snow and/or ice traction.

In one embodiment, grooves **108** and **110** comprise a groove base **118** and **120**, respectively. In one embodiment, groove **108** comprises at least one cross-groove negative geometry **122** and **124**. In one embodiment, at least one cross-groove negative geometry **122** comprises a substantially straight sipe. In another embodiment, at least one cross-groove negative geometry **122** comprises any of a variety of sipe configurations, including for example: a straight sipe, a curved sipe, or an angled sipe.

In one embodiment, at least one cross-groove negative geometry **122** comprises sipes oriented substantially parallel to one another. In another embodiment, at least one cross-

groove negative geometry **122** is oriented at any angle relative to the axial axis of the tire. In another embodiment, at least one cross-groove negative geometry **122** is oriented substantially parallel to the axial axis of the tire. In another embodiment, at least one cross-groove negative geometry **122** is oriented substantially perpendicular to the axial axis of the tire. In one embodiment, a first series of at least one cross-groove negative geometry **122** includes a plurality of sipes oriented substantially parallel to one another and angled in a first direction, and a second series of at least one cross-groove negative geometry **122** includes a plurality of sipes oriented substantially parallel to one another and angled in a second direction. In one embodiment, a plurality of cross-groove negative geometries **122** are oriented adjacent one another in a substantially non-parallel configuration. Groove **110** may comprise at least one cross-groove negative geometry **126** oriented in the same or similar manner as at least one cross-groove negative geometry **122**.

In one embodiment, at least one cross-groove negative geometry **124** comprises a zigzag sipe. In one embodiment, tread portion **100** comprises grooves **108** and **110** comprising a plurality of cross-groove negative geometries **124** and **128**, respectively, in a zigzag configuration oriented adjacent one another. In one embodiment, at least one cross-groove negative geometry **124** comprises a zigzag sipe extending in a substantially axial direction along tread portion **100**. In another embodiment, at least one cross-groove negative geometry **124** comprises a zigzag sipe extending in any of a variety of directions along tread portion **100**, including for example: along an axial axis, along a longitudinal axis, or angled relative to an axial axis. At least one cross-groove negative geometry **128** may be oriented in the same or similar manner as at least one cross-groove negative geometry **124**.

In one embodiment, cross-groove negative geometries **122**, **124**, **126**, and **128** extend radially inwardly from groove bases **118** and **120**.

In one embodiment, cross-groove negative geometries **122**, **124**, **126**, and **128** comprise any of a variety of elements, including combinations of different elements, in any of a variety of patterns, including for example: a sipe, a zigzag sipe, a curved sipe, interlocking sipes, intersecting sipes, a notch, a slot, a void, or a texture with negative geometry. Negative geometry is understood to include any element extending radially inwardly from a groove base. Any pattern of cross-groove negative geometries **122**, **124**, **126**, and **128** that are configured to provide increased traction upon snow and/or ice may be used.

In one embodiment, a sipe in tread portion **100** is formed by inserting an element into a tread mold. In another embodiment, a sipe in tread portion **100** comprises a width of about 0.75 mm.

In one embodiment, a slot in tread portion **100** is formed by a raised portion in a tread mold. In another embodiment, a slot in tread portion **100** comprises a width greater than about 0.75 mm.

In one embodiment, a texture includes any texture configured to provide increased traction upon snow and/or ice.

In one embodiment, tread portion **100** comprises ribs **102**, **104**, and **106** optimized for dry/wet conditions, grooves **108** and **110** having a depth configured to sufficiently channel and evacuate water, and cross-groove negative geometries **122**, **124**, **126**, and **128** within grooves **108** and

**110** to the snow/ice. At least one of cross-groove negative geometries **122**, **124**, **126**, and **128** within grooves **108** and **110** may engage the snow/ice and create traction between tread portion **100** and the snow/ice. In one embodiment, at least one of cross-groove negative geometries **122**, **124**, **126**, and **128** within grooves **108** and **110** may comprise an edge configured to engage the snow/ice and create traction between tread portion **100** and the snow/ice.

Tread portion **100** may comprise a tread width TW1. Tread width TW1 may represent the total width of tread portion **100**. Groove **108** may comprise a groove width W1. Groove **110** may comprise a groove width W2.

In one embodiment, tread portion **100** comprises a groove-rib ratio. The groove-rib ratio may be calculated by: (1) adding the widths of each groove (for example, W1 and W2) to obtain a total groove width; (2) subtracting the total groove width from the tread width TW1 to obtain a total rib width; and (3) dividing the total groove width by the total rib width.

In one embodiment, tread portion **100** comprises a higher than average (compared to similar tires) groove-rib ratio. Increased groove-rib ratio results in more area in the at least one groove (for example, **108** and **110**) of tread portion **100**. Increased groove area may result in increased traction between tread portion **100** and snow when tread portion **100** is exposed to snow/ice.

Tread portion **100** may comprise any distribution of rib versus groove. Tread portion **100** may comprise ribs and grooves of any of a variety of widths.

In another embodiment, tread portion **100** comprises a lower than average (compared to similar tires) groove-rib ratio. In another embodiment, tread portion **100** comprises an average (compared to similar tires) groove-rib ratio.

While FIG. 1 illustrates a tread portion **100** comprising three ribs (**102**, **104**, and **106**) and two grooves (**108** and **110**), it is contemplated that any number of grooves or ribs could be utilized in connection with this design. Similarly, it is contemplated that this design could be applied to any of a variety of tread patterns utilized in tires, including all-season patterns, summer patterns, winter patterns, and the like. Additionally, it is contemplated that this design could be applied to any of a variety of tire types, including passenger tires, truck tires, bus tires, off-the-road tires, agricultural tires, and the like.

FIG. 2 illustrates a cross-sectional view of an example embodiment of a tire comprising a tread portion **200**. Tread portion **200** may comprise at least one rib **202**, **204**, and **206**. Tread portion **200** may additionally comprise at least one groove **208** and **210**.

In one embodiment, groove **208** comprises a groove base **218**. In another embodiment, groove **210** comprises a groove base **220**. In one embodiment, groove **208** comprises at least one cross-groove negative geometry **224**. In another embodiment, groove **210** comprises at least one cross-groove negative geometry **226**. As illustrated in FIG. 2, at least one cross-groove negative geometries **224** and **226** extend radially inwardly from groove bases **218** and **220**.

In one embodiment, at least one cross-groove negative geometry **224** extends radially inwardly from groove base **218**. At least one cross-groove negative geometry **224** may extend radially inwardly to a depth of H1. In one embodiment, at least one cross-groove negative geometry **226** extends radially inwardly from groove base **220**. At least one cross-groove negative geometry **226** may extend radially inwardly to a depth of H2.

In one embodiment, at least one groove **208** comprises a depth D1, which is measured from the radially outward-

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most portion of ribs **202** and **204** to groove base **218**. In one embodiment, at least one groove **210** comprises a depth **D2**, which is measured from the radially outward-most portion of ribs **204** and **206** to groove base **220**.

In one embodiment, depth **D1** and depth **D2** comprise about an average tread depth (compared to similar tires). In another embodiment, depth **D1** and depth **D2** comprise a depth sufficient for channeling and evacuation of water within grooves **208** and **210**. In another embodiment, depth **D1** and depth **D2** comprise a depth configured to increase tread height, thus leading to increased tread life.

In one embodiment, groove **208** comprises a cross-sectional area defined by multiplying depth **D1** and groove width **W1**. In one embodiment, groove **208**'s cross-sectional area is about an average groove cross-sectional area (compared to similar tires). Groove **208**'s cross-sectional area may be adjusted by varying depth **D1** and/or groove width **W1**.

In one embodiment, groove **210** comprises a cross-sectional area defined by multiplying depth **D2** and groove width **W2**. In one embodiment, groove **210**'s cross-sectional area is about an average groove cross-sectional area (compared to similar tires). Groove **210**'s cross-sectional area may be adjusted by varying depth **D2** and/or groove width **W2**.

In one embodiment, tread portion **200** comprises an M-gauge value measured from the groove bases **218** and **220** radially inward to the radially outward-most reinforcing layer. In one embodiment, the M-gauge value in tread portion **200** is greater than a comparable tire, so as to accommodate cross-groove negative geometries **224** and **226**.

FIG. 3 illustrates an example embodiment of a prior art tire comprising a tread portion **300**. Tread portion **300** comprises at least one rib **302**, **304**, and **306**, and at least one groove **308** and **310**.

Ribs **302**, **304**, and **306** comprise tread blocks **312**, **314**, and **316**, respectively.

Groove **308** comprises a groove base **318** and a width **W3**. Groove **310** comprises a groove base **320** and a width **W4**. Tread portion **300** comprises a tread width **TW2**.

Tread portion **300** comprises a groove-rib ratio less than that of tread portion **100**.

FIG. 4 illustrates an example embodiment of a prior art tire comprising a tread portion **400**. Tread portion **400** comprises at least one rib **402**, **404**, and **406**, and at least one groove **408** and **410**.

Groove **408** comprises a groove base **418** and a depth **D3**. Groove **410** comprises a groove base **420** and a depth **D4**.

In one embodiment, **D1** and **D2** as illustrated in FIG. 2 are substantially equal to **D3** and **D4**. In another embodiment, **D1** and **D2** as illustrated in FIG. 2 are less than **D3** and **D4**. In another embodiment, **D1** and **D2** as illustrated in FIG. 2 are greater than **D3** and **D4**.

To the extent that the term "includes" or "including" is used in the specification or the claims, it is intended to be inclusive in a manner similar to the term "comprising" as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term "or" is employed (e.g., A or B) it is intended to mean "A or B but not both" then the term "only A or B but not both" will be employed. Thus, use of the term "or" herein is the inclusive, and not the exclusive use. See Bryan A. Garner, A Dictionary of Modern Legal Usage 624 (2d. Ed. 1995). Also, to the extent that the terms "in" or "into" are used in the specification or the claims, it is intended to additionally

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mean "on" or "onto." To the extent that the term "substantially" is used in the specification or the claims, it is intended to take into consideration the degree of precision available or prudent in manufacturing. To the extent that the term "selectively" is used in the specification or the claims, it is intended to refer to a condition of a component wherein a user of the apparatus may activate or deactivate the feature or function of the component as is necessary or desired in use of the apparatus. To the extent that the term "operatively connected" is used in the specification or the claims, it is intended to mean that the identified components are connected in a way to perform a designated function. As used in the specification and the claims, the singular forms "a," "an," and "the" include the plural. Finally, where the term "about" is used in conjunction with a number, it is intended to include  $\pm 10\%$  of the number. In other words, "about 10" may mean from 9 to 11.

As stated above, while the present application has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art, having the benefit of the present application. Therefore, the application, in its broader aspects, is not limited to the specific details, illustrative examples shown, or any apparatus referred to. Departures may be made from such details, examples, and apparatuses without departing from the spirit or scope of the general inventive concept.

What is claimed is:

1. A tire, comprising:

a tread portion comprising at least one groove having a groove base,

wherein the groove base comprises at least one cross-groove negative geometry,

wherein the at least one cross-groove negative geometry comprises:

a plurality of a first type of cross-groove negative geometries; and

a plurality of a second type of cross-groove negative geometries;

wherein the plurality of the first type of cross-groove negative geometries and the plurality of the second type of cross-groove negative geometries are provided in the same groove,

wherein the plurality of the first type of cross-groove negative geometries comprise a plurality of groups consisting of a plurality of zigzag sipes, each group separated by predetermined distance,

wherein the plurality of the second type of cross-groove negative geometries comprise a plurality of straight sipes, and

wherein the plurality of the second type of cross-groove negative geometries are positioned between the groups of the plurality of zigzag sipes.

2. The tire of claim 1, wherein the tire is a pneumatic tire.

3. The tire of claim 1, wherein the tire is a passenger tire.

4. The tire of claim 1, wherein the tread portion comprises at least one rib, and wherein the at least one rib comprises at least one of a dry grip tread compound and a wet grip tread compound.

5. A tire, comprising:

a tread portion comprising at least one groove having a groove base,

wherein the groove comprises at least one cross-groove negative geometry extending radially inwardly from the groove base,

wherein the at least one cross-groove negative geometry comprises:

a plurality of a first type of cross-groove negative geometries configured in a group, wherein the plurality of the first type of cross-groove negative geometries is separated by a predetermined distance;

a plurality of a second type of cross-groove negative geometries configured in a group, wherein the plurality of the second type of cross-groove negative geometries is separated by a predetermined distance;

wherein the group of the first type of cross-groove negative geometries and the group of the second type of cross-groove negative geometries are provided alternately in the same groove and separated by a predetermined distance.

6. The tire of claim 5, wherein the tire is a pneumatic tire.

7. The tire of claim 5, wherein the tire is a passenger tire.

8. The tire of claim 5, wherein the tread portion comprises at least one rib, and wherein the at least one rib comprises at least one of a dry grip tread compound and a wet grip tread compound.

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